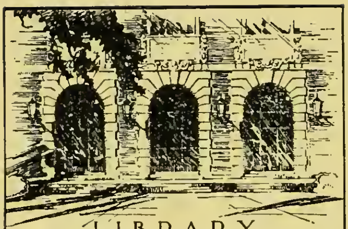


MOTION and TIME Study

Institute of Labor and Industrial Relations

NIVERSITY OF ILLINOIS

ULLETIN

EDITORIAL NOTE

This University of Illinois *Bulletin* is the second of three to be published by the Institute of Labor and Industrial Relations on Industrial Engineering topics. The topics are *Job Evaluation, Motion and Time Study,* and *Wage Incentives.* These *Bulletins* are not intended to "promote" the use of these techniques, but to aid managements and unions which have decided to adopt them.

The Institute of Labor and Industrial Relations was established at the University of Illinois in 1946 to "inquire faithfully, honestly, and impartially into labor-management problems of all types, and secure the facts which will lay the foundation for future progress in the whole field of labor relations."

The *Bulletin* series is designed to carry out these aims by presenting information and ideas on subjects of interest to persons active in the field of labor-management relations. These *Bulletins* are nontechnical, for general and popular use.

Additional copies of this *Bulletin* and others are available for distribution.

ROBBEN W. FLEMING, *Director*

BARBARA D. DENNIS, *Editor*

I.L.I.R. BULLETIN NO. 24

(The number 24 represents the total number of *Bulletins* published by the Institute of Labor and Industrial Relations to date. This series was originally called Series A and later I.L.I.R. Publications, Bulletin Series, with Volume and Number. Hereafter I.L.I.R. *Bulletins* will be published at irregular intervals and will be numbered consecutively. I.L.I.R. Publications, Bulletin Series, Vol. 6, No. 1, *Workers on the Move,* published in September, 1952, is the *Bulletin* in this series immediately preceding this publication.)

UNIVERSITY OF ILLINOIS BULLETIN

Volume 51, Number 73: June, 1954. Published seven times each month by the University of Illinois. Entered as second-class matter December 11, 1912, at the post office at Urbana, Illinois, under the Act of August 24, 1912. Office of Publication, 207 Administration Building, Urbana, Illinois.

Motion and Time Study

by

L. C. PIGAGE

Associate Professor of Mechanical Engineering and Labor and Industrial Relations

J. L. TUCKER

Chief Industrial Engineer, Coffing Hoist Company. Former Instructor of Mechanical Engineering in Labor and Industrial Relations and Extension

TABLE OF CONTENTS

Introduction

To mention motion and time study to a group of workers, or to a group of management representatives, is a certain way to start an involved discussion.

Even with a history of some 50 years, many points are still debated. Time study was first used by Frederick W. Taylor while he was working at the Midvale Steel Company in the 1890's. At about the same time Frank B. Gilbreth applied motion study to bricklaying as a means of improving his contracting business.

Perhaps some day agreement may be reached on a scientific procedure to follow in motion and time study. But at the present time we can only suggest some general methods which can be modified to fit a situation being considered.

Human judgment has always been a strong factor to be overcome in attempting to remove the difficulties that surround this subject. The people in the shop, particularly those who are organized into unions, are suspicious of motion and time study. They are especially critical of the rating phase of time study — which has not been too satisfactory in many instances.

Motion and time study affects the way a man works and how much he gets for his work. These things are vital to him. He finds it difficult to accept any change without understanding the reason for it. In most cases, motion and time study is not fully understood by those not actually trained to work with the technique. Often the lack of understanding and the misapplication of motion and time study are responsible for much of the controversy.

This *Bulletin* is written to explain methods used in motion and time study, to suggest an approach to its many problems, and to assist in developing a working program in the field.

Why Have Motion and Time Study?

Managements of manufacturing concerns feel that economy of effort and cost are extremely important factors in the operation of a plant. In many cases they use motion and time study as one of the techniques to achieve this economy. In addition, they give serious consideration to the effect of production economy on the buying public. They try to set the selling price of a product at a level the customer is willing and able to pay. Frequently, if the product is a good one, well known, and sold at a reasonable price, a manufacturer may gain a leading position in the field. Thus he is able to maintain good profits and security.

In order to price a product, most manufacturers try to determine and lower three major cost factors — material, overhead, and labor. Motion and time study has dealt mainly with labor costs. Yet it is affected by many complex variables such as the understanding of the whole field of motivation. It is this technical treatment of the subject, without due regard for the human being, which has caused many motion and time study systems to get into untenable positions in industry.

For example, Jim and Ed are two workers. Each does exactly the same work, and each is apparently trying to do a good job. Yet, upon closer examination, it is found that Jim produces quite a bit more than Ed — even though Ed appears to be working harder than Jim. This situation isn't serious enough to create an immediate price emergency for the company, but it does warrant an investigation to find out why Ed doesn't produce as much as Jim. Perhaps there is some way to find out exactly what Jim does that enables him to produce so well. If the "know-how" that Jim possesses can be divided into simple steps and

explained clearly to Ed, and to the other Eds in the plant, their jobs will become easier to perform and will cause fewer headaches for everyone.

Here motion study comes into the picture. Through the use of motion study, the job can be broken down into steps, and each step can be analyzed to see if it is being done in the simplest, easiest, and safest possible manner. Jim probably knows a few short-cuts that help him do his job in less time and with less effort. By using motion study, it will be possible to find out just what these are.

At this point Ed can be helped by motion study. The job has been broken down into simple steps that are easy to explain, easy to understand, and easy to follow. Now he will be able to realize some good production results and get these results with less effort than he used before.

Time study is the recording of the time needed to do a certain amount of work in a certain way. It is tied in directly with the specific method of doing the work and is good only for that method. The use of time study permits the company to complete the picture of labor cost and also provides a fixed base so the worker will know what is expected of him during a certain period of time.

What does this mean to the company, and eventually to Jim and Ed? It means that the company can constantly improve its position in the competitive market and can maintain a good profit margin. This may result in more benefits for Jim and Ed — greater job security and higher wages. Moreover, their work will be easier.

Motion and Time Study in the Wage Structure

In the technical sense, motion and time study can be placed between the job evaluation system and the specific wage incentive plan used in the company. The motion and time study program establishes the minimum expected rate of production on each job to which it is applied for the base money rate being paid for that job. (The base money rate for the job may change from time to time due to changing economic conditions and social outlooks, but the time standard should remain the same as long as the method of doing the job is not changed.)

Furthermore, motion and time study programs set the basis for wage incentive systems. Through the use of motion and time study, the unit base of measure for extra pay for extra production above the acceptable minimum is established. (This whole relationship is more fully explained in *Job Evaluation*, a *Bulletin* previously published by the University of Illinois.)

Motion Study

Motion and time study is not scientific throughout. The techniques do attempt to follow a scientific procedure, but there is room for considerable improvement. To achieve rational and reasonable results it is essential to use motion and time study together to determine a production standard. It is particularly important that reasonable effort be applied in motion study to insure equitable results when time study is used. In fact, much of the difficulty with time study, aside from lack of scientific procedure, is a result of applying it without a thorough study of the motion pattern of the job.

Basically, motion study is the foundation for time study. The time study determines the time to do the job according to a certain method and is valid only so long as the method is continued. Once a new way to do the job is developed, the time study must be changed to agree with the new method. Otherwise the time allowed for the job would be too great, and a loose standard would result. This, in turn, would mean inconsistent standards or unequal opportunity for all persons on incentive work to earn essentially equal bonuses.

Motion study can be used successfully without time study — but time study cannot be used without motion study. Since motion study is the foundation for time study and should be done before a time study is made, this *Bulletin* will consider motion study techniques first.

The purpose of motion study should be to find the greatest economy of effort with due regard for safety and the human aspect. The total cost for human expenditure of effort can be reduced at the same time that the unit cost for human effort is increased. The same amount of work can be accomplished in less time with more efficient application of human effort which will justify higher hourly wage rates.

Any job can be motion-studied. The achievement of reduced human effort may be harder to secure on some jobs than on others, but this is no excuse for not applying motion study in many places other than on factory jobs. In fact, motion study can be applied very effectively to jobs in the home, in the office, in retail and distribution fields, and in many other areas.

Stated simply, motion study means —

1. Find out how a job is being done now.

2. Thoroughly question the reason for each step as it is being done now on the job.

3. Remove the steps on the job which cannot be fully justified.

4. Install and standardize the new procedure for doing the job. The job study may be simple or elaborate — depending on the desires of those making the study and the people on the job. The amount of time and money to be spent may limit the scope of the study.

The ideas as outlined in the following pages will give a fair concept of some of the possible motion study techniques which can be used. These samples of techniques, simply illustrated, with supporting procedures, will give the reader an idea of relatively uniform practices now prevailing. No attempt is made to cover all the possible variations that may exist.

The usual and tested procedures in motion study involve the use of —

1. Process charts. The study of a series of steps in making an article or the series of events a person goes through in completing a job assignment.

2. Flow charts. A supporting route of travel that an article or person may take in completing a series of steps in a job assignment. This chart is usually used to supplement the process chart.

3. Operations charts. A detailed analysis of just what an employee does in a specific step or task.

4. Micromotion (simo) charts. An elaborate breakdown of an operation chart into very fine motion patterns, showing what the employee does in a specific step or task.

The above is the accepted order of study of processes and jobs. Not all are necessary, but usually the process, flow, and operation charts are made. This *Bulletin* will consider, in turn, each type of chart in the motion study procedure. But a person with a sheet of ordinary paper and a pencil can achieve equally good results — even though specific forms are shown in the subsequent illustrations.

PROCESS CHART

Before one studies each and every step in a series used to complete an article or product, it is well to take a look at the over-all picture. This means that all the steps should be considered in relation to each other. The idea of this over-all view is to decide —

1. Are all the steps now used to complete the product or task necessary?

2. Are the various steps done in the proper order?

3. Is there waste of time and effort between the various "do" parts of the series of steps?

To study the over-all situation, one usually makes a process chart and a flow diagram. On the process chart, all the various steps involved

in furthering the product from raw material to final finished form are listed in the order in which they now exist. It is essential that each and every phase of the series of steps in the over-all picture be shown. No assumptions should be made. Above all, it is highly desirable to observe the series of events on the actual scene instead of trying to picture what is taking place from a distant office.

As an illustration of a process chart, consider the simple series of events encountered in preparing a bottled soda to drink. This might occur in any home, and the illustration was purposely selected so that the reader might duplicate the process chart in his own home. Note that every step in the series is shown, regardless of the extent of the step. Furthermore, this chart was made by actually observing a person performing the job sequence. See Figure I.

It can be seen from this process chart that, along with the general identification material and summary, there are three detail parts to the body of the chart. These are (1) description of the step, (2) symbol, and (3) distance involved. A fourth detail, the time for each step, could be listed and often is.

The symbols used may look somewhat queer, but, with usage, one will soon discover that they assist in spotting features about a series of steps which will lead to simplifying the process. The symbols used in this and any chart are —

- ◯ — an operation, a step which progresses the product through change in shape, etc., along to completion.
- ○ — a move operation, a transportation from one location to another, but not involving a change in shape of the product nor progressing the product along to completion.
- ▽ — a temporary storage, a waiting of the article or product for the next event to happen.
- ▽ — a permanent storage, a waiting of the article or product for the next event to happen. This differs from temporary storage in that an order is required before the next event can take place.
- ◇ — an inspection of a quality nature.
- □ — an inspection of a quantity nature.

Now, returning to the illustrated process chart (Figure I), note several features that would and should be questioned. There are (1) several moves involving considerable distance to secure the finished product and (2) several operations which may be readily simplified. The extent of a change depends upon the costs one may be able to undertake. Simple changes usually can be made without actual — or with minor — money outlay. In this case, one-third of the distance traveled could be saved by relocating the refrigerator and bottle opener. (This is particularly evident when one looks at the flow chart, Figure II.)

PROCESS CHART

Present METHOD

Page 1 of 1

Process Prepare bottled beverage to drink

Depts. Home Parts Soda, Refrigerator, Opener Part No's. None

Charted by John Doe Date Any time

Distance	Symbol	Explanation
	▽	Rest on sofa
	○	Stand up
30 ft.	◦	Walk to refrigerator
	○	Open refrigerator door
	○	Get bottle of beverage
	○	Close refrigerator door
9 ft.	◦	Walk to opener (on wall)
	○	Open bottle
19 ft.	◦	Walk to wall cabinet
	○	Get a glass
12 ft.	◦	Walk to sink
	○	Pour beverage into glass
	○	Set bottle aside in sink
30 ft.	◦	Walk to sofa
	○	Sit down
	▽	Rest on sofa

SUMMARY

No. of operations	9
No. of movements	5
Distance of movements	99 ft.
No. of storages	2

LCP-52-Form I

FIGURE I

FLOW CHART

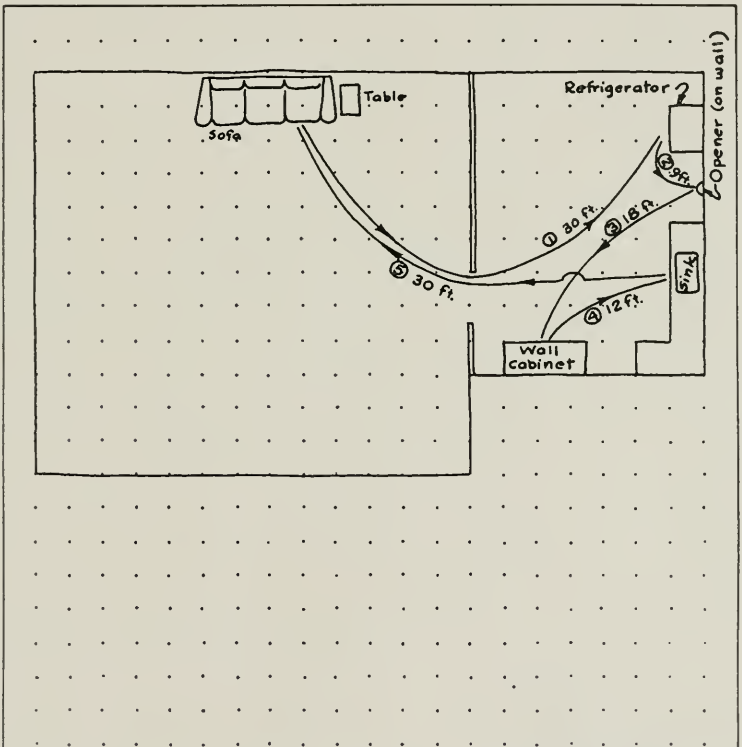
Present METHOD

Page 1 of 1

Process Flow diagram - Prepare bottled beverage to drink

Depts. Home Parts Soda, Refrigerator, Opener Part No's. None

Charted by John Doe Date Any time



Scale - each square 2 ft.

LCP-52-Form 2

FIGURE II

PROCESS CHART

Improved METHOD

Page 1 of 1

Process: Prepare bottled beverage to drink

Depts.: Home — Parts: Soda, Refrigerator, Opener — Part No's.: None

Charted by: Jon Doe — Date: Later-any time

Distance	Symbol	Explanation
	▽	Rest on sofa
	○	Stand up
24 ft.	◦	Walk to wall cabinet
	○	Get glass
6 ft.	◦	Walk to refrigerator
	○	Open refrigerator door
	○	Get bottle of beverage
	○	Close refrigerator door
3 ft.	◦	Walk to opener (on side of base cabinet)
	○	Open bottle
6 ft.	◦	Walk to sink
	○	Pour bererage into glass
	○	Set bottle aside in sink
30 ft.	◦	Walk to sofa
	○	Sit down
	▽	Rest on sofa

SUMMARY

	Improved Method	Original Method	Savings
No. of operations	9	9	–
No. of movements	5	5	–
Distance of movements	69 ft.	99 ft.	30 ft.
No. of storages	2	2	–

LCP-52-Form I

FIGURE III

FLOW CHART

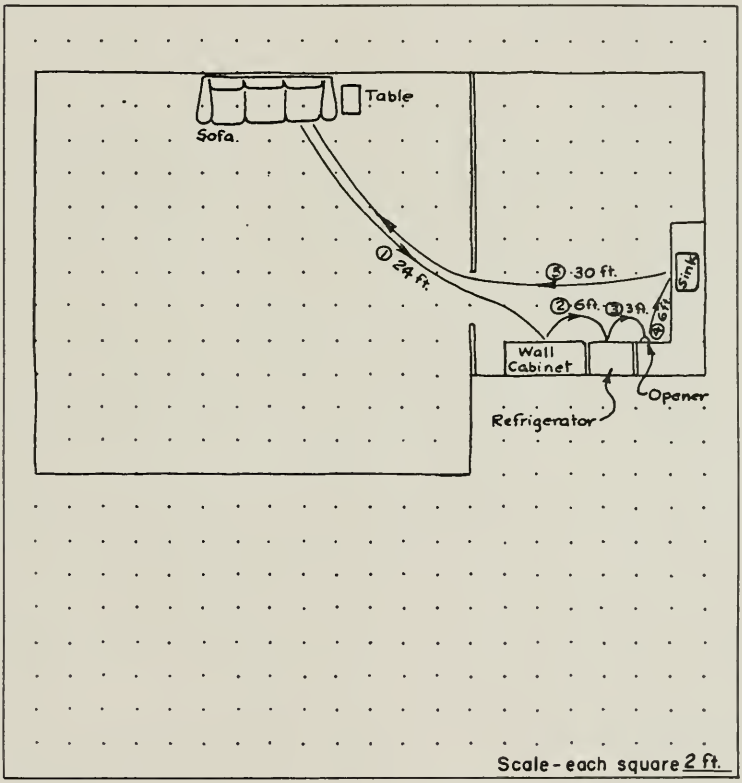
Improved METHOD

Page 1 of 1

Process Flow diagram - Prepare bottled beverage to drink

Depts. Home Parts Soda, Refrigerator, Opener Part No's. None

Charted by Jon Doe Date Later-any time



LCP-52-Form 2

FIGURE IV

These simple changes resulted in the improved process chart shown in Figure III and the corresponding improved flow chart shown in Figure IV. Further changes in equipment could have resulted in even more saving of time and effort, but some money would have to be spent for these improvements.

FLOW CHART

This chart, as seen in Figure II, is really a "road map" of the series of events. It brings out more clearly the extent of the moving-around involved even in this simple illustration. The general practice is to have a flow chart accompany every process chart. The flow chart is drawn to any convenient scale.

OPERATION CHART

Even though no operations were eliminated in the improved process and flow charts illustrated, there are many cases where they could be. Because some operations can be eliminated or combined with others, an individual operation study should follow an over-all (process chart) study. In this way, time will not be wasted studying or retaining an unnecessary series of events.

Each operation should be studied to find —

1. What the operator does in accomplishing the task.
2. Why the operator does each part in accomplishing the task.
3. What is not absolutely necessary to accomplish the task so that a more effective use of effort can be suggested.

It does not take much time and energy to discover that many parts of a job involve the use of human effort to accomplish little or nothing — except that the worker gets tired. This does not imply an insult to the many skilled operators of today. It is simply that parts of many jobs, and in some cases whole jobs, "just grew up like Topsy" without sufficient thought as to why they are done as they are. In fact, some people on the job or very close to the job do not realize just how much effort is wasted until they stop and take stock of what is being done.

Furthermore — and this is important — many operators on the same job and production-standard-time-allowed will produce at different rates because of the different methods they use rather than because of how fast they work. This is especially true when the operators are left more or less on their own to develop their own methods on the job. This idea was suggested in the introductory pages of this *Bulletin*. The operator is placed in a very difficult position when he is given the production-standard-time-allowed without the specific method. He has to stumble

on the proper or better method to meet the time standard while still working at a reasonable pace.

Various means can be used to secure the information as to what an operator does to accomplish a task, but the most satisfactory has been a two-column chart.

1. For a single operator — one column shows what the left hand is doing and the other column shows what the right hand is doing at the same time throughout the task. See Figure V. (Additional columns may be used to show foot lever operations, etc.)

2. For an operator and a helper — one column shows what the operator is doing and the other shows what the helper is doing at the same time.

3. For an operator and a machine — one column shows what the operator is doing and the other shows what the machine is doing at the same time.

4. Various combinations of the above three situations.

Turning to specifics and looking at Figure V, the reader can see what the operator actually was doing when he was straightening a welded "T" bracket. This particular method does not reflect on his intelligence. He was trying to get the task accomplished. But the reader will note that several times throughout the accomplishment of the task, one hand or the other was idle. Also, the operator spent a lot of time handling the work without actually straightening the bracket. The motion study engineer did not intend to overwork the operator in correcting these conditions, but aimed to help him use his effort more constructively. With these thoughts in mind, a simple straightening block was constructed. This block retained the bracket in proper position for the straightening operation. Now an analysis of what the operator does reveals effective use of both hands. See Figure VI.

These operation charts not only serve as a means to simplify an operation, but —

1. They are excellent instruction guides to train new operators properly.

2. They are sound bases for the method being employed when the time study is made.

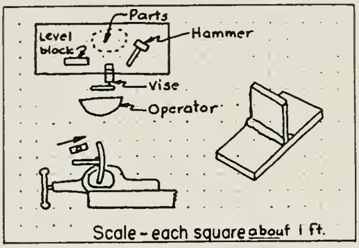
3. They are highly useful when grievances on production standards or changes in production arise.

Although further improvements could be realized through the use of a special arbor press in the specific task illustrated, it can be seen that much can be accomplished in operation analysis without excessive expenditure of money. Above all, human endeavor can be directed to accomplishing the task more effectively.

OPERATION CHART

Present METHOD

Page 1 of 1



Operation Straighten Welded "T" Bracket

Operation No. 25 Dept. 13

Parts Weld "T" Bracket Part No. 1040

Machine Bench Mach. No. None

Specif. No. None Draw. No. None

Operator & No. U. Doit Fixt. No. None

Charted by Jan Doe Date Any time

Left hand	Right hand
Reach for part	Wait for left hand
Grasp part	
Carry to vise	Reach for vise handle
Position in vise	Grasp handle
Hold for tightening vise	Tighten vise
Release part	Release handle
	Reach for hammer
	Grasp hammer
Idle	Carry hammer to vise
	Hit part to straighten
	Carry hammer aside
	Release hammer
Reach for part	Reach for vise handle
Grasp part	Grasp vice handle
Hold part	Open vise
Remove part from vise	Release vise handle
Carry part to level block	
Sight part for straightness	Idle
Aside part	
Release part	

SUMMARY

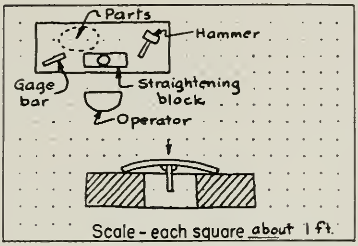
L.H.		R.H.
7	Operations	9
5	Movements	5
3	Holds & delays	2

LCP-52-Form 3

FIGURE V

OPERATION CHART

Suggested METHOD



Page 1 of 1

Operation Straighten Welded "T" Bracket

Operation No. 25 Dept. 13

Parts Weld "T" Bracket Part No. 1040

Machine Bench Mach. No. None

Specif. No. None Draw. No. None

Operator & No. U. Doit Fixt. No. S101

Charted by Jon Doe Date Any time

Left hand	Right hand
Reach for part	Reach for hammer
Grasp part	Grasp hammer
Carry part to block	Carry hammer to block
Position part in hole in block	Wait
Release part	Strike part
Reach for gage bar	Aside hammer
Grasp gage bar	Release hammer
Carry gage bar to part	Reach for part
Gage part for straightness	Grasp part
Aside gage bar	Aside part
Release gage bar	Release part

SUMMARY

L. H.		R. H.
6	Operations	5
5	Movements	5
—	Holds & Delays	1

COMPARISON

Original Method		Suggested Method
16	Operations	11
10	Movements	10
5	Holds & Delays	1

LCP-52-Form 3

FIGURE VI

MICROMOTION (SIMO) CHART

In some cases it is found that a more detailed investigation is needed. The technique employed for detailed analysis is called micromotion study and the chart used is a micromotion or simo chart. Frank B. and Dr. Lillian Gilbreth, who originally developed this method of motion study, found that all work could be broken down into 17 basic body motions. These basic motions were called "therbligs" (a form of Gilbreth in reverse) and are still known by that name. All jobs involve various combinations of these basic motions, and their interrelationships play a very important part in the analysis of jobs which are short in duration and rapid in performance. In fact, micromotion study technique is favored over other motion study methods because it can measure rapid jobs more effectively.

Because these motions are small and difficult to record, the Gilbreths also developed the use of a motion picture camera and a timing device for studying and measuring the basic motion patterns involved in doing work. Micromotion study is not too widely used at the present time because many work improvements can be realized with the more simple forms of analysis. A micromotion study program is costly, and this also limits its use by many organizations.

Before rejecting micromotion study because of cost, serious consideration should be given to its many advantages. In long range planning, the detailed analysis may be well worth the investment. Some of the advantages are that micromotion study —

1. Provides more detail than other methods of observation.
2. Is more accurate than other methods.
3. Is more convenient than other methods.
   a. The work can be studied at leisure from a film.
   b. The film can be stopped at any place in the cycle and restudied.
4. Provides automatic timing.
5. Provides a permanent record free of errors.
6. Is useful in training operating personnel and methods analysts.
7. Allows observer to study all types of jobs and various crews.
8. Is useful as a basis for developing standard data.

A more detailed discussion of micromotion study may be found in the many excellent texts mentioned in the bibliography.

CONCLUSION

To date there have been many ideas and principles developed for motion study. These principles or rules are good for checking a person's work to insure adequate coverage of the possibilities of work simplification. An open mind and plenty of common sense are essential in doing motion study work.

Time Study

Once the method of doing the work has been determined by motion study, it is often desirable to find out how much time is used to do the work. Many industries have adopted some sort of a time study system to record the time on a job. The name *time study* implies that some sort of a time-measuring device must be used. In most cases it is a stopwatch. This particular area is more familiar to the employee because he is able to observe at least the physical aspects of a time study man with his stopwatch and board.

Before taking a time study, it is necessary to understand just what a time study attempts to do.

> A time study attempts to find out the amount of work that a qualified operator, properly trained, can do in a given time. The operator must do the work according to a certain method, under certain conditions, and at a certain pace which will produce a certain physical reaction. Certain allowances for personal and other delays are provided.

In this explanation, "certain" is used several times. It is the problem of each individual plant to determine the exact specifications for the "certain" method, "certain" conditions, "certain" pace, "certain" physical reaction, and "certain" allowances. Just how the specifications are determined — unilaterally by management or bilaterally by management and the employees or union — is decided in each case by the person or persons involved. But it must be remembered that the employees' acceptance of the final answer — the production-standard-time to be allowed — is one of the criteria for the success of time study.

All phases — job method, working conditions, pace, and allowances — must be carefully considered if the time study is to be rational. It is unreasonable to expect a production worker to accept and meet or exceed a production standard that is not based on these phases. It is with this idea in mind that the following suggested steps in time study, with the rationale expressed in each case, are considered. This is necessary because only a scientific procedure is attempted; some parts of taking a time study are an art.

APPROACHING THE EMPLOYEE AND JOB TO BE TIME-STUDIED

From the technical aspect, this first step of the time study series is not too important. However, from the psychological point of view, it is perhaps the one which determines whether the idea of time study is

accepted or rejected. In most cases, the employee's first contact with time study comes when he sees the time study man with his board and stopwatch.

Much has been written about approaching an employee and getting his cooperation in any endeavor. In this case, the time study engineer should consider all the ideas expressed by others and, after careful thought, use the ones most applicable to the situation. Assuming that the other phases outlined in the following pages are adequately covered, the approach to the employee when properly handled does much toward securing a good and sound time study with the facilities available today.

The time study engineer should approach the employee with the idea of seeking cooperation and should make him feel at ease. But this cannot be done with a "mightier-than-thou" attitude. The engineer should give the employee an idea of what the study is all about. And he should welcome the employee's thoughts and ideas.

Before the engineer takes any actual time values, he should establish that the job is properly set up and that the method used is the one to be used until changes are made. In other words, the job should be reasonably standardized, and the qualified operator properly trained in the work method should be selected.

DETERMINING THE JOB CONTENT

The determination of job content involves recording the method of doing the job exactly as it is done when the time study is taken. This should be done in such detail that the work can be reproduced at any time in the future. Details include recording —

1. The general information about the job.
2. The workplace description.
3. The conditions and environment surrounding the workplace.
4. The method used by the operator.

The record obtained is of the utmost importance for the administration of a sound time study system because it provides information for —

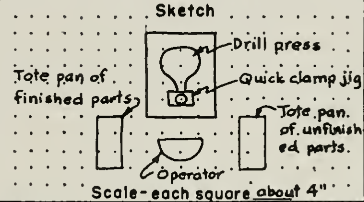
1. Determining the magnitude of job changes as they occur.
2. Training other operators in the standard method to enable them to meet the standard time.
3. Developing standard time data.

The importance of making the proper record of the time study is further emphasized when the consequences of an incomplete description are considered. An incomplete time study record can cause the standard times to become useless because the operators cannot be trained to meet them. Without proper records inaccuracies develop in the standard time

TIME STUDY SHEET

Operation: Drill 3/16" pin hole — Page 1 of 2
Operation No. 10 — Dept. Machine Shop — Study No. 1
Operator: R. W. Smith — Oper. No. 36 — Draw. No. 10-0-27
Parts: Stay pin — Part No's. D-27 — Specif. No. 1040
Machine: Cyclone — Mach. No. 357 — Fixt. No. D-27
Study by: D. R. Jones — Approved by: — Date: Any time

Sketch



Notes

1. Lighting good - fairly clean room
2. Moderate noise level
3. Comfortable seat - operator can stand
4. Supply boxes poorly supported - on wooden crates 18" high
5. Material supplied to and taken from operator
6. Machine operated at 1200 rpm using high speed drill

Elem. No.	Operation Description: Left hand	Operation Description: Right hand	Allowed Time
	Open clamp, release, grasp piece	Raise drill to clear stock	
	Aside finished piece, release	Raise drill to rest position,	
	and reach for quick clamp	release	
	on jig, and grasp and clamp	Reach for next piece, grasp and	
		carry to quick clamp jig	
	Clamp piece in jig and hold	Position piece to jig, release	
	clamp	Reach for drill press handle,	
		grasp and lower drill to stock	
	Hold clamp	Drill 3/16" pin hole (hand feed)	

LCP-52-Form 5a

Allowed time in ___ per ___ piece ___

FIGURE VII
Method description (front of form)

because of changes in method, equipment, workplace, and surroundings which cannot be checked. Perhaps the most chaotic result is the gradual development of undesirable attitudes on the part of the people on the job. They begin to associate standard times with production quotas rather than as measurements of the physical work required. This feeling leads to a resistance to change, even though the suggested method requires no increase in physical effort.

Before considering the methods description complete, two important questions should be asked:

1. Can the job be reproduced from the methods description?
2. Does the description include everything the worker has to do?

To show how a time study builds up to completion, the same job will be used as an illustration in all cases. Each step will be discussed and shown on the time study form in turn. The previous discussion dealt with determining the job content. Figure VII illustrates this step for a simple drill press job.

DETERMINING THE ELEMENTS OF THE JOB

Time values of a job can be secured in a number of different ways. Perhaps the two extremes would be (1) to secure the over-all time to do the whole job and divide this time by the number of pieces or pounds produced to get a unit measure and (2) to determine the time for each motion and a total of all the motion times for one unit produced to give a unit measure. Between these two extremes are any number of possibilities, and it is usually one of these other methods that is used. In other words, the job is broken down into parts and the parts are timed. The parts are known as *elements.*

There are no fixed regulations as to how a job should be broken down into elements, but there are a few guides which can be used. The rest has to be built up through experience. The guides are —

1. Contents of each element should be as homogeneous as possible. This means that a unit of work such as "insert a screw" should be in one element, but other units of work in the same job should be in other elements.

2. Hand and machine times should be placed in different elements. Hand time is under the operator's control and is subject to rating or leveling. Machine time, under automatic feed, is a definite value depending upon the physical characteristics of the part being made and equipment used. This can be determined without actual time study.

3. Each element should be either a relatively constant time value element or a variable time value element. The same element of work in one job will appear in many other jobs — especially in similar work.

However, in some cases because of the physical characteristic of the part being made (such as size), the time value for the same element will be different from job to job. This is known as a variable element. In other cases, the varying work factors such as size, weight, shape, and difficulty of handling will not affect the time for the same element from job to job. If this is the case, the element will be classified as a constant element. The value of having an element variable or constant is much more apparent when standard data, or standard time values, are being developed.

4. Each element should, insofar as possible, have a definite start and end point. In order to secure comparable time values for the same element, the start and end points should be fairly definite so the watch can be read at the right time each time the element occurs.

One may find that the time recording means may not permit breaking a job into certain elements. For example, it is not advisable to use an ordinary stopwatch for elements less than 0.04 minutes. If the element is shorter, a different timing device, such as a movie camera, should be used; or else two or more elements should be combined into one.

To illustrate, Figure VIIIa shows the simple drill press job with the method of doing the job broken down into elements for a stopwatch time study. The end point of each element — the point at which the stopwatch is read — is underscored. (The end point of one element is the starting point for the next element.) In the particular case illustrated, the right hand is the controlling one for each element, but this is not always the case.

Figure VIIIb shows the element end points, or the points at which the watch is read, on the time recording side (back of form) of the time study sheet.

Occasionally some elements may not appear every time a piece or part is made. These elements are described as if they were regular elements, but time values will appear only at irregular intervals. A note usually accompanies the description of these irregular elements to suggest how often they occur, so that proportional amounts of time can be allowed for them on each piece or pound produced. (Figure IX illustrates the irregular element as well as other features.)

RECORDING THE ACTUAL TIME VALUES

In recording the actual time values, two questions need to be answered:

1. What method of reading a stopwatch is going to be used?

2. When have an adequate number of stopwatch readings been secured?

TIME STUDY SHEET

Operation ____________________________ Page __ of __

Operation No. ______________ Dept. __________ Study No. ____

Operator ______________ Oper. No. __________ Draw. No. ____

Ports ______________ Part No's. __________ Specif. No. ____

Machine ______________ Mach. No. __________ Fixt. No. ____

Study by ______________ Approved by __________ Date ____

Sketch	Notes
Scale - each square ____	

Elem No.	Operation Description		Allowed Time
	Left hand	Right hand	
1	Open clamp, release, grasp piece	Raise drill to clear stock	
	Aside finished piece, release	Raise drill to rest position,	
	and reach for quick clamp	release	
	on jig, and grasp and clamp	Reach for next piece, grasp and	
		carry to quick clamp jig	
2	Clamp piece in jig and hold	Position piece to jig, release	
	clamp	Reach for drill press handle,	
		grasp and lower drill to stock	
3	Hold clamp	Drill 3/16" pin hole (hand feed)	

LCP-52-Form 5a

Allowed time in ____ per ____ piece __

FIGURE VIIIa
Element description (front of form)

Page 2 of 2

Start study ____________

End study ____________

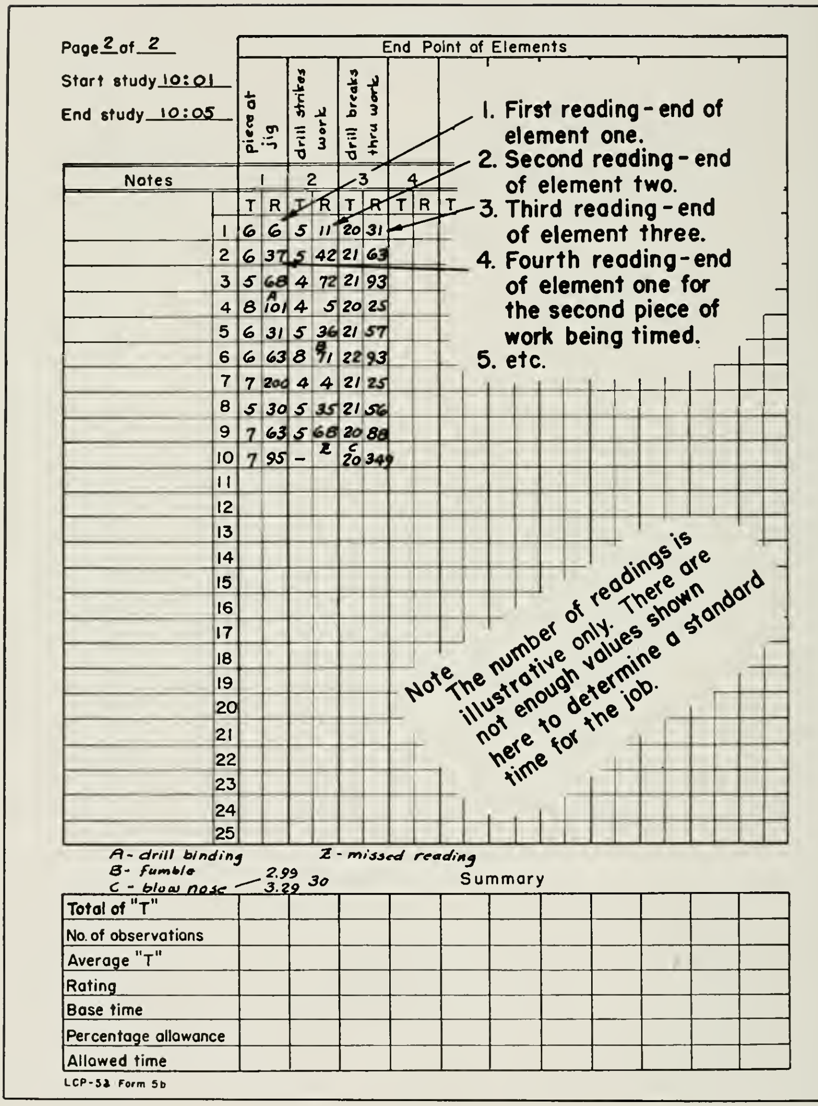
Notes		End Point of Elements																					
		piece at jig		drill strikes work		drill breaks thru work																	
		1		2		3		4		5		6		7		8		9		10		11	
		T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R
	1																						
	2																						
	3																						
	4																						
	5																						
	6																						
	7																						
	8																						
	9																						
	10																						
	11																						
	12																						
	13																						
	14																						
	15																						
	16																						
	17																						
	18																						
	19																						
	20																						
	21																						
	22																						
	23																						
	24																						
	25																						

Summary

Total of "T"											
No. of observations											
Average "T"											
Rating											
Base time											
Percentage allowance											
Allowed time											

LCP-52-Form 5b

FIGURE VIII b
Element description (back of form)



Page 2 of 2

Start study 10:01

End study 10:05

Notes		End Point of Elements: 1 piece at jig		2 drill strikes work		3 drill breaks thru work		4	
		T	R	T	R	T	R	T	R
	1	6	6	5	11	20	31		
	2	6	37	5	42	21	63		
	3	5	68	4	72	21	93		
	4	8	A 101	4	5	20	25		
	5	6	31	5	36	21	57		
	6	6	63	8	B 71	22	93		
	7	7	200	4	4	21	25		
	8	5	30	5	35	21	56		
	9	7	63	5	68	20	88		
	10	7	95	–	Z	C 20	349		
	11								
	12								
	13								
	14								
	15								
	16								
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

1. First reading - end of element one.
2. Second reading - end of element two.
3. Third reading - end of element three.
4. Fourth reading - end of element one for the second piece of work being timed.
5. etc.

Note The number of readings is illustrative only. There are not enough values shown here to determine a standard time for the job.

A - drill binding
B - fumble
C - blow nose — 2.99 3.29 30
Z - missed reading

Summary

Total of "T"										
No. of observations										
Average "T"										
Rating										
Base time										
Percentage allowance										
Allowed time										

LCP-52 Form 5b

FIGURE IX
Continuous method of stopwatch reading and recording

Page 2 of 2

Start study 10:01

End study 10:05

Notes		End Point of Elements: 1 piece at jig		2 drill strikes work		3 drill breaks thru work		4	
		T	R	T	R	T	R	T	R
	1	6		5		20			
	2	6		5		21			
	3	5		4		21			
	4	A 8		4		20			
	5	6		5		21			
	6	6		B 8		22			
	7	7		4		21			
	8	5		5		21			
	9	7		5		20			
	10	7		Z –		C 20			
	11								
	12								
	13								
	14								
	15								
	16								
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

1. Reading and also time for element one.
2. Reading and also time for element two.
3. Reading and also time for element three.
4. etc.

Note: The number of readings is illustrative only. There are not enough values shown here to determine a standard time for the job.

A- drill binding
B- fumble
C- blow nose 30
Z- missed reading

Summary

Total of "T"											
No. of observations											
Average "T"											
Rating											
Base time											
Percentage allowance											
Allowed time											

LCP-52-Form 5b

FIGURE X

Snapback method of stopwatch reading and recording

With respect to the method of stopwatch reading, it can be said that the accuracy and reliability of the particular method depends entirely on the person handling the watch. In spite of the many pro and con arguments on the merits of continuous and snapback (known also as repetitive) fundamental methods of stopwatch reading, there is as yet insufficient proof that one system is better than the other. The selection of a method depends upon the time study department's preference and the acceptance of the selected method by the working force.

The description of the two methods outlined below, with illustrations, should provide sufficient information as to how each method of reading and recording operates.

Continuous Stopwatch Reading and Recording. The stopwatch is started at the beginning of the first element of the job description and runs continuously until the study is completed. At the end of each element, in turn, the particular reading of the watch is recorded for the corresponding element. In Figure IX under R in column one, line one, the watch read 0.06 minutes at the end of the first element. The watch continued to run, and in the same column on line two, it read 0.11 minutes at the end of element two. The reading at the end of the third element was 0.31 minutes. The watch continued to run so that at the end of the first element of the second piece of work, the watch read 0.37 minutes. The decimal point is not shown in the recording since all values are in hundredths of a minute. A decimal minute watch, the most popular, was used.

The time for each element is secured by subtracting successive readings. For example, element one for the first piece was 0.06 minutes, since the watch started at zero and read 0.06 minutes at the end of the first element. For the second element of the same piece, the time was 0.05 minutes. This was secured by subtracting the watch reading at the end of element one (0.06 minutes) from the reading at the end of element two (0.11 minutes). All these "subtracted times," the time for the element in each case, appear in the T part of the vertical column.

Snapback or Repetitive Stopwatch Reading and Recording. The stopwatch is started at the beginning of each element. At the end of each element, the watch is read and the hand is snapped back to zero. It starts again for the next element. Because in all cases the time values are for just the particular element being timed, the values can be recorded directly in the T part of the vertical column. See Figure X for a recording of time values by the snapback method of stopwatch reading and recording. (As a matter of interest, compare the respective T parts of the vertical columns of Figures IX and X. They should be the same if the readings are accurate.)

The second consideration when securing the actual time values involved in doing a job is to determine when an adequate number of values has been secured. In other words, how many time values must one secure to have a reasonable and sound sample to represent the job? There are two extreme possibilities here: (1) take a complete time study of the whole job from the first piece or pound to the last piece or pound (assuming a sizable number of pieces), or (2) take enough readings of time values until it is felt that a reasonable sample has been secured. The first method is much too costly and the answer comes too late for use. It would mean issuing a production-standard-time-allowed after the job is done.

The second method is most widely used, but the rationale of enough readings is left entirely up to the time study man. There is a way to overcome this disadvantage of the "feeling" of enough readings. By using statistics, actual limitations can be set. But for those who wish to make a reasonably rough check graphically, a simple means is available: Plot a frequency chart. To use a specific situation, consider the data from Figure X for element one. The time values are shown in Table I.

TABLE I

Time Values for Element One

PIECE	TIME	PIECE	TIME
1	6	6	6
2	6	7	7
3	5	8	5
4	8	9	7
5	6	10	7

Now two scales can be laid out at right angles to each other on a sheet of cross-section paper. See Figure XI. The horizontal scales show the different time values secured in element one from the lowest to the highest. The vertical scale shows the number of times each time value appears in the element. Note that the distribution is bell-shaped around a time value which appears more frequently than others. There must be enough time values to give this bell-shaped distribution before a rational sample of the job has been secured. This procedure must be repeated for each element to insure that all have the bell-shaped distribution of time values. When each element meets this test, a reasonable

sample of the operator's time to do the job has been determined. If the distribution skews appreciably to the right or left, the time values should be rejected.

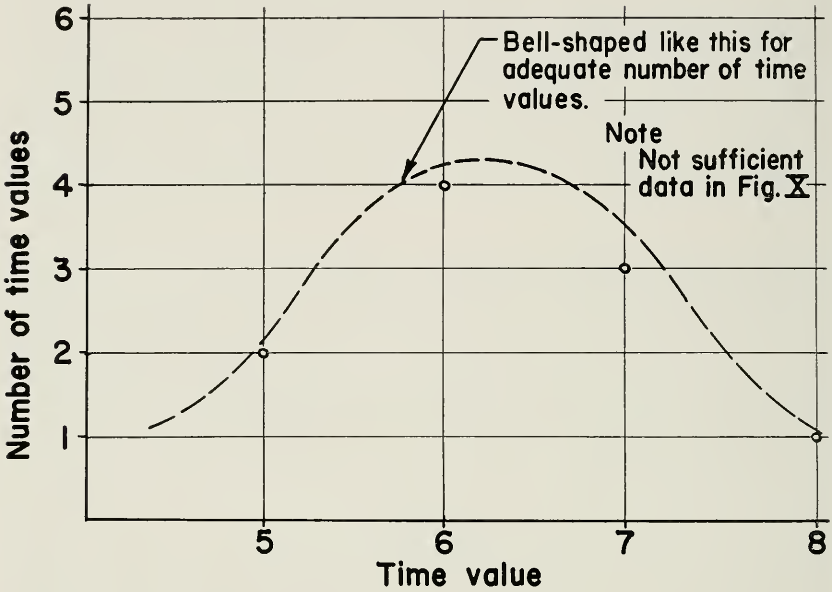


FIGURE XI
Frequency distribution of time values for element one

DETERMINING THE AVERAGE TIME TO DO THE JOB BY A CERTAIN OPERATOR

The previous step assumed that all time values secured during the time study were proper. But questions always come up as to the validity of certain so-called "abnormal" time values — those which are too high or too low. This question has to be settled on a rational basis. To hide behind the idea that a time is abnormal is not enough. A sound, workable policy that can be understood by anyone is necessary. To avoid the misuse of the idea of abnormal time values, consideration of this policy is suggested:

> All time values for an element are to be included in determining the average time for an operator studied, unless a specific note is made in each case of a discarded time value that the job method was not followed.
>
> This means that if all the work called for in the element of the job is not done, the time value (which probably will be low) will be discarded. If the operator unnecessarily does more work than

the element of the job calls for, the time value (which probably will be too high) also will be discarded.

Figure XII shows the calculations of the average time for each element for the operator studied. These values are secured by adding

Page__of____

Start study_______

End study_______

End Point of Elements										

Notes		1		2		3		4		5		6		7		8		9		10		11	
		T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R
	1																						
	2																						
	3																						
	4																						
	5																						
	6																						
	7																						
	8																						
	9																						
	10																						
	11																						
	12																						
	13																						
	14																						
	15																						
	16																						
	17																						
	18																						
	19																						
	20																						
	21																						
	22																						
	23																						
	24																						
	25																						

The reason for 8 observations is that one time value was discarded because of variations in method and one time value was missed during the study. See Figures IX or X.

Summary

Total of "T"	0.63	0.37	2.07								
No. of observations	10	8	10								
Average "T"	0.06	0.05	0.21								
Rating											
Base time											
Percentage allowance											
Allowed time											

LCP-52-Form 5b

FIGURE XII
Average time for job by a certain operator

the time values for each element in turn and dividing the total by the number of time values considered in each case. For example, element one time values total 0.63 minutes. Ten time values make up this total. Dividing the total (0.63 minutes) by ten gives an average time of 0.06 minutes for element one. Note that this average time is for the specific operator studied.

DETERMINING THE BASE TIME FOR THE JOB BY RATING OR LEVELING

So far, the average time value secured for each element of the job was that displayed by a certain operator. But it must be remembered that in any field of human endeavor — whether it is housework, farming, or industrial work — observation will show that people differ in manner and speed at which they accomplish a task. The situation is not any different in time study work. It is reasonable to expect that no two persons will perform a given task at exactly the same speed, although this may happen occasionally. Yet, when a standard time is set for a job, the time study engineer is saying that a certain worker, following a certain method, working at a certain speed, and under certain conditions, should be able to do the job properly in at least the standard time.

The problem confronting the observer is how to watch different people doing work at different speeds and how to compare them to some person who is working at a certain speed already determined for a certain existing area, industry, or plant. The process of comparing a worker's rate of performance with the performance expected of a person working at the selected speed for the area, industry, or plant is called *rating* or *leveling.*

The rating process is a systematic attempt to relate the observed performance to the performance expected from a certain type of individual who has certain skill qualifications, who follows a certain method, and who works under certain conditions and at a certain pace.

Although many methods of rating have been devised, none has yet been able to remove the factor of human judgment satisfactorily. In the future a better practice may be found. At the present time, rating based on sound judgment developed through extensive training is the best procedure to follow. Achieving satisfactory rating also means achieving equity for all employees affected by the time study program. If rating equity is not realized, a very unfavorable situation of unbalanced costs and employee dissatisfaction may develop.

Achieving equity of rating involves consideration of several rules:

1. All raters must practice fairness.

2. All raters in any one plant must use the same basic reference.

3. All raters must be consistent and accurate in their judgment.

4. Rating must be concrete and based on some observable, demonstrable basis.

5. It is desirable that both management and labor understand and agree to the basis of rating.

6. Rating judgment must involve the determination of the effect of the operator's skill, aptitude, and degree of exertion on his performance compared to the definition of standard performance. Consideration of these factors shows that —

a. Skill determines how rapidly a job can be done by a certain method. Hence, skill is reflected in *pace*.

b. Aptitude under a given method determines what speed of pace can be maintained. Hence, aptitude is reflected in *pace*.

c. Exertion is a function of job difficulty and pace. Hence, exertion, which is the physical effort of work, is reflected in *pace*.

Therefore, it is suggested that the observer rate only *pace or rate of activity*. Selecting some physical representation of standard performance is an extremely important step which can influence the success of the rating program. The selection can be successful if a typical job is carefully chosen for the particular situation considered — provided that the pace for the typical job is agreeable to both management and labor. Selecting a typical job satisfies the need for a basic reference that is concrete, observable, and demonstrable. Proper training of the raters can meet the need for consistency and accuracy. This usually can be done effectively by using a motion picture film loop of typical jobs for rating practice.

With the "certain" pace represented as 100 (some use 60), the pace displayed by the operator time-studied is determined and shown on the time study sheet. Figure XIII shows the calculations for the base time (minimum acceptable) for qualified operators working under the conditions listed in the above definition. In element one the rating was 110 per cent. Hence, the average time multiplied by rating gives the base time.

DETERMINING AND APPLYING ALLOWANCES

Regardless of the occupation, certain interruptions will occur during a regular working day. No operator can be reasonably expected to work a full shift without some stoppages that are beyond his control. Interruptions vary from those of very short duration, which are difficult to measure, to those of moderate or long duration, which are fairly easy to measure. Delays which are caused by the nature of the work situation

Page__of____

Start study________

End study________

		End Point of Elements																					
Notes		1		2		3		4		5		6		7		8		9		10		11	
		T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R
	1																						
	2																						
	3																						
	4																						
	5																						
	6																						
	7																						
	8																						
	9																						
	10																						
	11																						
	12																						
	13																						
	14																						
	15																						
	16																						
	17																						
	18																						
	19																						
	20																						
	21																						
	22																						
	23																						
	24																						
	25																						

Summary

Total of "T"											
No. of observations											
Average "T"	0.06	0.05	0.21								
Rating	110	90	100								
Base time	0.07	0.04	0.21								
Percentage allowance											
Allowed time											

LCP-52-Form 5b

FIGURE XIII
Using rating to secure base time

should not be permitted to act as a penalty upon the operator. Stoppages which are long enough to be recorded on a time card do not present a measurement problem because the time card is the measurement device in this case. However, a definite policy should establish which type and duration of delays are to be covered in the delay allowances in time study and which are to be covered by the time card.

Minor, varied delays of short duration present an extremely difficult measurement problem. They are often difficult to detect or determine properly without exhaustive study, and consequently they are overlooked in many cases. This should not be. A properly administered, workable time study system is based upon fair play. Proper allowances for delays — no matter how minor — are essential if fairness to all is to be achieved. These allowances can be determined only by careful, extensive studies taken on the job under regular working conditions. No attempt should be made to apply standard reference tables which may not fit the situation.

Although delay studies may not be absolutely accurate, they are valuable if carefully and conscientiously taken. Allowances for personal needs, such as food, drink, and toilet, and rest allowances can be determined by study and agreement between management and labor.

All studies made to determine the amount of delay that can be expected in various types of work have a definite relationship to the production time. Basically, the acceptable total work day is composed of net production time and acceptable delay times.

Because at this point the base time or net production time is known (see Figure XIII), it would be convenient to apply the delays to be allowed as a percentage of the base time after the various delay percentages are known. The per cent allowance for delay for each class of delay can be computed from the studies made for the delay times expected. The formula is —

$$\text{Per cent allowance for delay} = \frac{\text{delay time}}{\text{net production time}} \times 100;$$

Then,

$$\text{Production-standard-time-allowed} = \text{base time} \times (1.00 + \text{per cent allowance for delay}).$$

The application of the total allowance per cent figure for the sum of the various allowances to the base time for each element is shown in Figure XIV. This results in the allowed time for each element of the job.

Now, transferring these final allowed times for each element (from Figure XIV) to the front of the time study sheet and summing them result in the production-standard-time-allowed, in this case, for one piece. A completed study which brings together all entries on Figures VII, VIII, IX, XII, XIII, and XIV is shown in Figures XVa and XVb.

Page__of____

Start study________

End study________

End Point of Elements										

Notes		1		2		3		4		5		6		7		8		9		10		11	
		T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R
	1																						
	2																						
	3																						
	4																						
	5																						
	6																						
	7																						
	8																						
	9																						
	10																						
	11																						
	12																						
	13																						
	14																						
	15																						
	16																						
	17																						
	18																						
	19																						
	20																						
	21																						
	22																						
	23																						
	24																						
	25																						

Summary

Total of "T"											
No. of observations											
Average "T"											
Rating											
Base time	0.07	0.04	0.21								
Percentage allowance	15	15	25								
Allowed time	0.08	0.05	0.26								

LCP-52-Form 5b

FIGURE XIV
Applying allowances

APPLYING THE STANDARD AS DETERMINED BY THE TIME STUDY

The application and administration of the time study program is perhaps the most vital part of the process. All of the other phases of

the program may be technically correct and practiced with conscientious diligence. However, they may be unacceptable to the people affected by the program because the administration fails to instill a feeling of honesty and fair play, because everyone affected does not understand the program thoroughly, or because the administration lacks a systematic approach to the workings of a time study program.

If the trust, respect, and cooperation of the people affected by the time study program are to be gained and kept, a definite policy for systematic operation of the time study program and the various activities of that program must be formed, definitely stated, and widely understood. The statement of policy is vital to all phases of plant activity and must include a statement of procedures, aims, and rules by which the organization functions under varying or recurring situations.

A statement of policy for a time study program should answer clearly at least the following:

1. *What does standard time represent?* Because this is a unit of measurement it must be defined, and the definition must be generally known throughout the plant.

2. *Who determines standard method?* Responsibility for determining methods must be delegated so that standard times will be used only with the methods they were designed for and so that there will be a constant striving for better methods.

3. *How will standard time be determined?* Time study, rating, and allowance procedures should be specified as well as any deviations that will be allowed in unusual cases. This will establish uniform practice. Policy for standard time should indicate —

   a. Nature of the method record.
   b. The manner of timing and possible use of standard data.
   c. Basis of rating.
   d. Standard allowances.
   e. Manner of handling irregular elements.
   f. Designation of responsibility for above work and authority for procedure modification.

4. *How will the standard method be installed?*

   a. Standard method in written practice form is supplied to operator.
   b. Standard time is supplied to operator.
   c. Full value can be obtained by use of improved methods.
   d. The practice form can be designed for use by operator, group leader, foreman, or instructor — the more detailed the form, the better the control.

TIME STUDY SHEET

Operation Drill 3/16" pin hole Page 1 of 2

Operation No. 10 Dept. Machine Shop Study No. 1

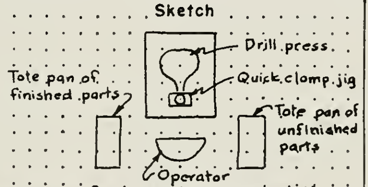
Operator R. W. Smith Oper. No. 36 Draw. No. 10-D-27

Parts Stay pin Part No's. D-27 Specif. No. 1040

Machine Cyclone Mach. No. 357 Fixt. No. D-27

Study by D. R. Jones Approved by L.C.P. Date Any time

Sketch



Scale - each square about 4"

Notes

1. Lighting good - fairly clean room
2. Moderate noise level
3. Comfortable seat - operator can stand
4. Supply boxes poorly supported - on wooden crates 18" high
5. Material supplied to and from operator
6. Material operated at 1200 rpm using high speed drill

Elem No.	Operation Description: Left hand	Operation Description: Right hand	Allowed Time
1	Open clamp, release, grasp piece	Raise drill to clear stock	0.08
	Aside finished piece, release	Raise drill to rest position,	
	and reach for quick clamp	release	
	on jig, and grasp and clamp	Reach for next piece, grasp and	
		carry to quick clamp jig	
2	Clamp piece in jig and hold	Position piece to jig, release	0.05
	clamp	Reach for drill press handle,	
		grasp and lower drill to stock	
3	Hold clamp	Drill 3/16" pin hole (hand feed)	0.26

LCP-52-Form 5a

Allowed time in min per 1 piece = 0.39

FIGURE. XV a
Complete study (front of form)

Page 2 of 2

Start study 10:01

End study 10:05

	End Point of Elements																					
	piece at jig		drill strikes work		drill breaks thru work																	
Notes	1		2		3		4		5		6		7		8		9		10		11	
	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R
1	6	6	5	11	20	31																
2	6	37	5	42	21	63																
3	5	68	4	72	21	93																
4	8	A 101	4	5	20	25																
5	6	31	5	36	21	57																
6	6	63	8	B 71	22	93																
7	7	200	4	4	21	25																
8	5	30	5	35	21	56																
9	7	63	6	68	20	88																
10	7	95	–	Z	C 20	349																
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
25																						

Note
The number of readings is illustrative only. There are not enough values shown here to determine a standard time for the job.

A - drill binding
B - fumble
C - blow nose — 2.99 3.29 30

Z - missed reading

Summary

	1	2	3	4	5	6	7	8	9	10	11
Total of "T"	0.63	0.37	2.07								
No. of observations	10	8	10								
Average "T"	0.06	0.05	0.21								
Rating	110	90	100								
Base time	0.07	0.04	0.21								
Percentage allowance	15	15	25								
Allowed time	0.08	0.05	0.26								

LCP-32-Form 5b

FIGURE XVb
Complete study (back of form)

5. *What are the conditions for change of standard time or method?*
   a. Properly set standards are guaranteed against revision except in specified cases, whereas poorly set standards require constant revision and lead to industrial chaos.
   b. Only a change in job method, working conditions, or job materials above a certain per cent of the total standard justifies a change in the standard.

Conclusion

This *Bulletin* has attempted to explain the various methods, uses, and ways of applying motion and time study. No attempt has been made to guide various groups into acceptance or rejection of this technique. Most managements decide whether or not they should use it after consideration of costs, possible economic benefits, and the effect on industrial relations.

In some cases, employee groups have completely rejected any application of motion and time study especially when it is used as a basis for an incentive wage system. Others have accepted the idea reluctantly at management's repeated insistence. On the other hand, many find the idea very attractive and accept it readily. Usually acceptance or rejection depends upon such things as tradition, experience, feelings of the members and officers, the group's strength as a bargaining unit, the type of plan being offered, its benefits, and relations with management. Whatever the reasons, if acceptance is decided upon, there are various ways of dealing with the situation.

Some employee groups refrain from any comment until after the methods and rates have been established, taking action on disagreement through the grievance procedure. Others have obtained the right to review before installations and also to use the action of the grievance procedure. The reviewing action may be taken by individuals selected in various sections of the shop, a committee, or both, depending on the situation. Active participation in some or all phases of method and rate determination is another procedure that many groups have accepted. This technique may vary from the use of observers who merely check and suggest to trained personnel who make motion and time studies in cooperation with company engineers.

The preceding discussion was intended to give an idea of some of the various approaches to the application of motion and time study. It was not intended to be a recommendation to anyone. The technique adopted depends entirely upon the complexity of the labor-management relationship that exists in each individual situation.

Selected Bibliography

BOOKS AND PAMPHLETS

Abruzzi, A. *Work Measurement,* Columbia University Press, New York, 1952, 290 pages.

Adams, S., and Weston, H. C. *On the Relief of Eyestrain Amongst Persons Performing Very Fine Work,* Industrial Fatigue Research Board, Report No. 49, 1928.

Barnes, R. M. *Motion and Time Study,* John Wiley and Sons, Inc., New York, 3rd Edition, 1949, 559 pages.

Bills, A. G. *The Psychology of Efficiency,* Harper & Brothers, New York, 1943.

Brooke, R. St. C., and Farmer, E. *Motion Study in Metal Polishing.* Industrial Fatigue Research Board, Report No. 15, 1921, pp. 1-65.

Carroll, Phil., Jr. *Timestudy Fundamentals for Foremen,* McGraw-Hill Book Company, New York, 1951, 225 pages.

Carroll, Phil., Jr. *How to Chart Timestudy Data,* McGraw-Hill Book Company, New York, 1950, 323 pages.

Carroll, Phil., Jr. *Time Study for Cost Control,* McGraw-Hill Book Company, New York, 1944, 172 pages.

Chane, G. W. *Motion and Time Study,* Harper & Brothers, New York, 1942, 88 pages.

Committee on Work in Industry, National Research Council. *Fatigue of Workers: Its Relation to Industrial Production,* New York, 1941.

Gillespie, J. J. *Dynamic Motion and Time Study,* Chemical Publishing Company, Brooklyn, 1951, 140 pages.

Gomberg, W. *A Trade Union Analysis of Time Study,* Science Research Associates, Chicago, 1948, 243 pages.

Hendry, J. W. *A Manual of Time and Motion Study,* Pitman and Sons, Ltd., London (Pitman Publishing Corp., New York), 1944, 215 pages.

Holmes, W. G. *Applied Time and Motion Study,* Ronald Press, Inc., New York, 1938.

Lowry, S. M., Maynard, H. B., and Stegemerten, G. J. *Time and Motion Study,* McGraw-Hill Book Company, New York, 3rd Edition, 1940, 532 pages.

Mathewson, S. B. *Restriction of Output Among Unorganized Workers,* Viking Press, Inc., New York, 1931.

Maynard, H. B., and Stegemerten, G. J. *Methods-Time Measurement,* McGraw-Hill Book Company, New York, 1944, 85 pages.

Maynard, H. B., Stegemerten, G. J., and Schwab, J. L. *Methods-Time Measurement,* McGraw-Hill Book Company, New York, 1948, 292 pages.

Maynard, H. B., and Stegemerten, G. J. *Operation Analysis,* McGraw-Hill Book Company, New York, 1939, 298 pages.

Morrow, R. L. *Time Study and Motion Economy,* Ronald Press, Inc., New York, 1946, 338 pages.

Mundel, M. E. *Motion and Time Study,* Prentice-Hall, Inc., New York, 1950, 457 pages.

Myers, H. J. *Simplified Time Study,* Ronald Press Company, New York, 1944, 140 pages.

Presgrove, R. *Dynamics of Time Study,* McGraw-Hill Book Company, New York, 2nd Edition, 1945, 238 pages.

Ryan, T. A. *Work and Effort,* Ronald Press Company, New York, 1947, 323 pages.

Sampter, H. C. *Motion Study,* Pitman Publishing Company, New York, 1941, 152 pages.

Schutt, W. H. *Time Study Engineering,* McGraw-Hill Book Company, New York, 1943, 426 pages.

Shumard, F. W. *Primer of Time Study,* McGraw-Hill Book Company, New York, 1940, 519 pages.

Sylvester, L. A. *The Handbook of Advanced Time-Motion Study,* Funk & Wagnalls Company, New York, 1950, 273 pages.

Uhrbrock, R. S. *A Psychologist Looks at Wage Incentive Methods,* American Management Association, Institute of Management Series, No. 15, 1935.

United Automobile, Aircraft, and Agricultural Implement Workers of America. *U.A.W.-C.I.O. Looks at Time Study,* International Union, Detroit, 1947, 31 pages.

United Electrical, Radio and Machine Workers of America. *U. E. Guide to Wage Payment, Time Study and Job Evaluation,* The Union, New York, 1943, 129 pages.

Vaughan, L. M., and Hardin, L. S. *Farm Work Simplification,* John Wiley and Sons, Inc., New York, 1949, 145 pages.

Vernon, H. M. *Industrial Fatigue and Efficiency,* E. P. Dutton and Company, New York, 1921.

Wyat, S. *Incentives in Repetitive Work,* Industrial Health Research Board (Great Britain), Report No. 69, 1934.

MAGAZINE ARTICLES

Adams, S., and Weston, H. C. "Observations on the Design of Cotton Machinery in Relation to the Operator," *Journal of National Institute of Industrial Psychology,* April, 1930, pp. 97-107.

Alford, L. P. "Looms per Weaver: Data from the Recent Silk and Rayon Work Assignment Study," *Textile World,* January, 1936, pp. 72-73.

"Applying Motion Study Principles: R. C. A. Manufacturing Company," *Factory Management and Maintenance,* August, 1942, pp. 182-189.

Barkin, S. "Labor Views the Working Day," *Advanced Management,* 1942, pp. 32-37.

Basset, W. R. "Modern Production Methods: Pt. XXVI — Time Study on Automatic Machines," *American Machinist,* January 19, 1922, pp. 87-90.

Bernard, V. "Time Studies in Foundry Work," *Foundry Trade Journal,* August 10, 17, 24, 1933, pp. 75-78, 96-98, 109-110.

Bernstein, P. "How Many Automatics Should a Man Run?" *Factory,* March 1941, pp. 85, 156, 158, 160, 162, 164.

Bitterman, M. E. "Fatigue Defined as Reduced Efficiency," *American Journal of Psychology,* 1944, pp. 565-572.

Brecht, R. P. "Motion Study in the Office," *Society for the Advancement of Management Journal,* July-September, 1936, pp. 110-114.

Campbell, J. F. "The Problem of Allowances in Time Studies as Viewed by the Industrial Engineer," *Taylor Society Bulletin and Society of Industrial Engineers,* January, 1935, pp. 46-49.

Carr, C. B. "Setting Time Standards When Machine Times Vary," *Factory,* December, 1939, pp. 48-50.

Carroll, Phil., Jr. "Exposing Some Fallacies of Time Study Technique," *Proceedings of National Time and Motion Study Clinic,* Industrial Management Society, 1939, pp. 62-81.

Carroll, Phil., Jr. "Time Studies from Standard Data," *Society for the Advancement of Management Journal,* January, 1939, pp. 20-24.

Dickey, R. C. "Time Sheets of Definite Value in Wood-Working Plants," *Wood Worker,* February, 1941, pp. 24-26.

Eyre, A. B., Lester, A. M., and Mitchell, J. H. "An Investigation in an Assembly Shop," *Human Factor,* July-August, 1935, pp. 268-273.

Fiske, R. A. "Synthetic Time Setting in a Jobbing Factory," *Iron Age,* April 27, 1933, pp. 655-659.

Gordy, C. B. "Variations in the Time Required for Skilled Operators to Perform a Simple Motion Task," *American Journal of Psychology,* 1943, pp. 56, 181.

Gore, J. O. "Time Studies of Drivers," *National Cleaner and Dyer,* October, 1934, pp. 29-30.

Greenberger, G. "You Can Use Time Studies and Standards," *Inland Printer,* August, 1940, pp. 27-28.

Habel, O. W., and Kearful, G. G. "Machine Design and Motion Economy," *Mechanical Engineering,* December, 1939, pp. 897-899.

Hartmon, W. C. "Application of Motion Study in Sears, Roebuck and Co.," *Society for the Advancement of Management Journal,* July-September, 1936, pp. 118-122.

Herzberg, A. A. "Inspection Keeps Pace," *American Machinist,* March 22, 1939, pp. 163-164.

Keever, H. K. "Time Study in a Plant Manufacturing a Variety of Machines," *Machinery,* May, 1928, pp. 702-703.

Lathrop, P. J. "Making Hand Labor Effective," *Modern Packaging,* July, 1941, p. 80.

Laufer, T. G. "Assembly Analysis," *American Machinist,* January 12, 1938, pp. 9-10.

Laufer, T. G. "Improving Machine Tool Efficiency with Time Study," *Mill and Factory,* April, 1936, pp. 39-40.

Lee, P. H. "Time Study Related to Bulk and Line Production," *Mechanical Handling,* July, 1941, pp. 130-131.

Marshall, G. P. "Reducing Cleaning Costs in the Shop," *Mill and Factory,* October, 1936, p. 57.

Matthews, P. M., and Brechin, C. H. "Incentives Cut Painting Costs," *Factory Management and Maintenance,* June, 1941, pp. 94-95.

Mogensen, A. H. "Motion Study: Why Has the Machine Designer Ignored It?" *Mechanical Engineering,* December, 1933, pp. 727-731.

Mundel, M. E. "Motion Study Aids Materials Handling," *Mill and Factory,* October, 1945, pp. 104-105.

Nissley, H. R. "Do Time Studies Result in Speed Up?" (abstract), *Management Review,* June, 1942, pp. 203-204.

Nuttall, J. H. "Time Studies of Refuse Collection Activities," *American City,* August, 1929, pp. 112-116.

Pollack, K. W. "The Use of Therblig. Times for Rate Setting," *Society for the Advancement of Management Journal,* March, 1937, pp. 35-40.

Rittenhouse, J. F., Jr. "Motion Study for Foremen and Shop Stewards," *Factory Management and Maintenance,* March, 1945, pp. 96-101.

Ryan, T. A. "Varieties of Fatigue," *American Journal of Psychology,* 1944, pp. 565-569.

Saute, A. J. "Ladles and Pouring Efficiency," *Foundry,* September, 1933, pp. 36-40.

Saxton, D. W. "Inspectors on Piece Rates Up Quality, Output, and Earnings," *Factory*, February, 1940, pp. 50-51.

Stegemerten, G. J. "Gage and Inspect — 1. Before Motion Study," *Factory*, February, 1936, pp. 66-67; "2. After Motion Study," *Factory*, March, 1936, pp. 104-105.

Tidball, L. D. "Time and Motion Study for Job Order Shops," *Rubber Age*, May, 1936, pp. 88-91.
